MSIAC's M&S Journal Online

Volume 4, December 2006

CAPABILITIES-BASED COSTING: APPROACHES TO PRE-MILESTONE-A COST ESTIMATING

Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE)
Arlington, VA 22202, United States

POC: Martha Roper
Senior Analyst, ODASA-CE
martha.roper@hqda.army.mil
(703) 601-4177

The issue of early, rigorous evaluation of program costs is becoming more important as defense funding comes under greater scrutiny. Often at this point in the life cycle, a requirement or desired capability is known, but the manifestation of the solution is unknown or described only at a high level. Can capabilities alone be used to produce a cost estimate? If so, how can we link the proposed solution to existing systems if only a particular solution's general capability set is known?

This work submits that better strategic decisions within fiscal constraints could be made if rough order of magnitude (ROM) estimates were available for proposed materiel or non-materiel solutions, based on that solution's capability set. This project further proposes the use of a knowledge base to provide support for these estimates; it is known as the joint Capabilities Knowledge Base (CKB). By using the relevant entities extracted from CKB, a ROM cost estimate may be developed using a wide spectrum of techniques.

According to Department of Defense (DoD) guidance dated June 19, 2006, the [2006] Quadrenniel Defense Review (QDR) report called upon senior departmental leaders to "better integrate the processes that define needed capabilities, identify solutions and allocate resources to acquire them in order to enable corporate decision-making that cuts across traditional stovepipes". In response to this directive, DoD leaders are evaluating a new early lifecycle decision-making framework that includes a Concept Decision (CD) Review (supported by an Evaluation of Alternatives or EoA). The CD Process has been set forth as a way to combine requirements, capabilities portfolio evaluation, and resource allocation considerations in the pursuit of joint, efficient, and well-informed decision-making early in the acquisition life cycle. The Concept Decision will either replace or occur in conjunction with Milestone A to decide which of the prospective solutions provided by the EoA will best enhance overall US defense capability while balancing priorities of cost, schedule, and risk management.

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
DEC 2006		**00-00-2006 to 00-00-2006**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
MSIAC Journal, Volume 4, December 2006	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Modeling and Simulation Information Analysis Center (MSIAC),1901 N. Beauregard Street Suite 500,Alexandria,VA,22311**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**11**	

The issue of early and rigorous evaluation of program costs becomes more and more important as defense funding becomes more scrutinized. Clearly, decision-makers need high-fidelity cost information at this key decision point, but more often than not, it is scant. Providing reliable, useful cost estimates very early in the acquisition life cycle is challenging for several reasons. Often at this point in the life cycle, a requirement or desired capability is known, but the manifestation of the solution is unknown or described only at a high level. This is certainly a challenge, given that defense cost estimating is usually performed given a detailed system description. Given the changing face of the battlefield and warfare, proposed solutions are often unlike anything presently in existence.

As any cost estimator can confirm, there exists a spectrum of situations in which a cost estimate may be prepared. One theoretic extreme is creating a cost estimate in a situation where there is very little information about the item being estimated and no supporting data. The other extreme is when the entity being estimated is fully understood, and all data exists to estimate the cost exactly. In this case, the data are actual costs after the item has been developed, constructed, or bought. Figure 1 shows these extrema along with all points in between.

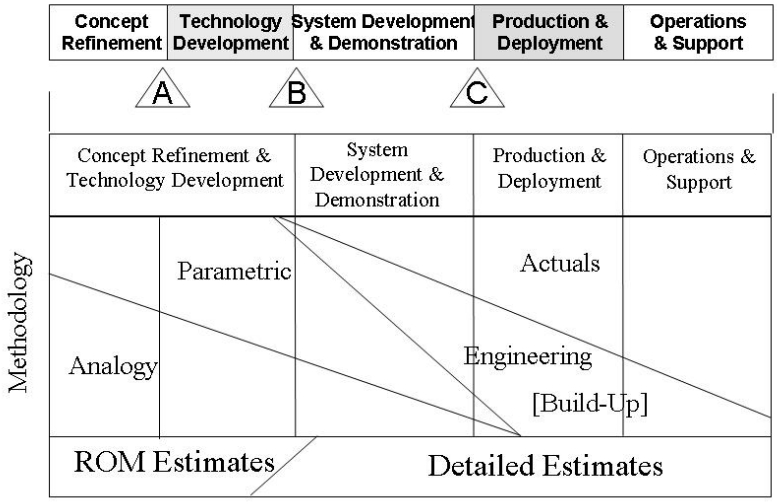

Figure 1: The Cost Estimating Spectrum

As we progress from the point of no information to the point of perfect information, our cost estimating methodology changes to suit the information climate. For instance, when information about the item or service is higher-level and/or data is not readily available (Figure 1, left), cost estimators tend to rely upon analogies and parametric methods to produce their estimate. However, as we move toward the right, estimates tend to utilize more "data-hungry" methodologies such as engineering builds and projections using actual costs to date. It is also clear to the casual observer that as we move along the spectrum from left to right, we may expect our estimate to be more reliable and closer to the actual cost at project or acquisition completion.

The pre-Milestone A costing environment is particularly challenging. This is the stage in which information is often extremely scarce. Figure 2 illustrates the "sub-spectrum" of pre-Milestone A data availability.

Figure 2: Spectrum of Information Availability at Milestone A

Depending upon the situation, there may be one or many proposed solutions to a set of capability gaps before Milestone A. These solutions could be a materiel system such as a vehicle or software package, or it could be a non-materiel solution, such as a policy change or a training curriculum change. As one can see in Figure 2, the information regarding the proposed solution(s) could range from simply the desired capability expressed in very qualitative terms to a relatively detailed, well-developed concept with some technical platform specifications. The most commonly-occurring scenario, however, is nearer to the middle where there exists high-level capabilities information along with some very general solution information.

Since every cost estimate of an item or project must be based on some type of past experience, pre-Milestone-A cost estimating is no exception. How can we link the proposed solution to existing systems (our past experience) if we know only a particular solution's general capability set? Can capabilities alone be used to produce a cost estimate? If so, could that cost estimate be used in decision-making with any degree of confidence?

Suppose we made the assumption that a system's capabilities have a relationship to its cost. To the casual observer, this assumption seems rather logical. If we buy something that can do more, do it quicker, or do it better, then it should cost more. However, one can identify situations in which this assumption might not hold; if a particular computer technology is maturing at an accelerated rate, the cost to acquire that capability might not be correlated to the cost of acquiring a similar capability five years ago. Yet, even this example has a relationship between capability and cost upon closer inspection; to arrive at an acceptable cost estimate one must understand the rate of technology maturation (and this maturity information may or may not be available to the analyst). The question at hand, however, is whether or not capabilities can predict cost within some acceptable level of percentage error to provide decision makers with data that helps avoid decisions that would yield negative future cost effects. In theory, these decisions could be avoided if a rough order of magnitude (ROM) estimate is available that is based on the proposed materiel solution's set of capabilities.

The capabilities costing team at the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE) is currently tackling the challenging pre-Milestone-A costing environment. Our approach includes the use of a knowledge base that records current system cost information and capabilities. In fact, the Joint Capabilities Knowledge Base (CKB) is presently under construction. By using the relevant entities extracted from the CKB, a ROM cost estimate may be developed using a wide spectrum of techniques.

Numerous costing approaches are being examined and developed as this project evolves, one of which follows: Let us assume that the set of capabilities requiring a cost estimate is rank-ordered; in other words, we know which capabilities among the group are most critical, somewhat necessary, or only slightly needed. Depending on whether the entities (that will be extracted from the CKB) have exact or partial matches in capabilities, we can then apply an appropriate weighting factor for certain combinations of capability matches; exact matches would receive a higher weighting than partial matches, for example. Next, relevant entities are extracted from the knowledge base that can be used in our cost estimate. The assigned weightings are applied. If a particular system entity is deemed to be even more relevant to the solution being estimated, it may be further emphasized in a variety of ways.

Larger-scale case studies using realistic scenarios are under development to test the usefulness and strength of the methodology frameworks being considered, which include simplistic techniques like that described above to more intricate parametric and data mining approaches. It is important, however, to emphasize that cost estimates at this point in the life cycle are highly situation-specific, and thus methodologies under development are only recommended strategies. The analyst's judgment is a key component.

Martha Roper is an Operations Research Analyst (ORA) with the Office of the Deputy Assistant Secretary of the Army for Cost and Economics (ODASA-CE). Ms. Roper is leading early-life cycle cost analysis initiatives in conjunction with analysts Nancy Houdek and Katherine McCormack.